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**HEWLETT-PACKARD COMPANY**
**3500 Deer Creek Road**
**Palo Alto, California 94303-0867**
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DOCKET FILE COPY ORIGINAL

April 7, 1994



Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: CC Docket No. 92-297

Dear Sir:

Pleased be advised that on April 6, 1994, the undersigned, accompanied by Dr. Mohammad S. Shakouri, Research and Development Engineer for Hewlett-Packard, Charles P. Mason, President of Wireless Communications Associates, and Lawrence Movshin, Wilkinson, Barker, Knauer & Quinn, his attorney, met with Robert James and Susan Magnotti of the Common Carrier Bureau's Domestic Facilities Division, to discuss certain concerns of Hewlett-Packard, more fully described in the attached "Comments". A copy of the viewgraphs used during my presentation is also enclosed.

This notice is being filed pursuant to Section 1.1206 of the Rules. Please do not hesitate to contact the undersigned should you have any questions concerning this matter.

Yours very sincerely,

Rory L. Van Tuyl
HEWLETT-PACKARD Laboratories

cc: Robert James
Susan Magnotti

Enclosures

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554



| | | |
|---|---|---|
| In the Matter of | ) | |
| | ) | |
| Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Frequency Band and to Establish Rules and Policies for Local Multipoint Distribution Service | ) | CC Docket No. |

## MOTION FOR LEAVE TO ACCEPT LATE FILED COMMENTS

Hewlett-Packard Co. ("HP"), hereby requests leave to file the attached Comments in the above-captioned proceeding out of time. (Comments were due on March 21, 1994.) In support of the instant motion, HP states the following:

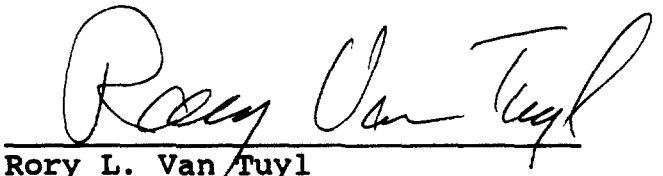
HP has been actively engaged in the consideration of technical solutions to the problems often encountered in utilizing the 28 GHz band as well as other spectrum above 20 GHz in fixed and mobile applications. All of HP's efforts have been directed to the technical aspects of this proceeding; thus, HP was not fully aware of the pending deadline for comments. Inadvertence, and not intentional delay, resulted in this late filing.

Moreover, these Comments discuss critical issues that should be addressed by the Advisory Committee. The Commission would be well-served in taking HP's Comments into account in chartering a Committee whose principal objective will be to develop rules that are technically sufficient to support both the satellite and land-based uses of this spectrum. Finally, since no opportunity for reply has been established, no other commenting party will be prejudiced by the acceptance of these Comments.

Based on the foregoing, HP submits that good cause exists for the late acceptance of the attached Comments. Accordingly, HP respectfully requests that the Commission grant its Motion for Leave and accept for filing HP's Comments in the above-captioned proceeding.

Respectfully submitted,

HEWLETT-PACKARD CO.



Rory L. Van Tuyl

3500 Deer Creek Road
Palo Alto, CA 94304-1392
(415) 857-6711

Dated: April 7, 1994

**Before the**
**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
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| | ) | RM-7872; RM-7722 |
| | ) | |
| | ) | |

Comments of Hewlett-Packard Co.
Re: Establishment of a Negotiated Rulemaking Committee for the 28 GHz Band

HEWLETT-PACKARD CO.

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(415) 857-6711

**Before the**
**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
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| Rulemaking to Amend Part 1 and Part 21 | ) | CC Docket No. 92-297 |
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| the 27.5 - 29.5 GHz Frequency Band and | ) | RM-7872; RM-7722 |
| to Establish Rules and Policies for | ) | |
| Local Multipoint Distribution Service | ) | |

Comments of Hewlett-Packard Co.
Re: Establishment of a Negotiated Rulemaking Committee for the 28 GHz Band

INTRODUCTION

Hewlett Packard Company [HP], an established manufacturer of microwave equipment, wishes to see as many beneficial applications of microwave technology as possible. In the 28 GHz band, two such applications include the proposed LMDS services, and satellite communication services. Proponents of both service types are presently in dispute over what use of the 28 GHz band best serves the public interest, and the Commission has asked for comments regarding the establishment of a Negotiated Rulemaking Committee (NRC) to resolve these differences. HP hopes to provide equipment to both LMDS and 28 GHz satellite services, as it has to other microwave services in the past. Therefore, we support the establishment of the NRC, but caution that the committee's proposed charter may need to be amended. While we concur with the Commission's views on digital modulation and video compression[1],

we oppose the imposition of any particular modulation scheme on LMDS.[2] We further caution that a rule requiring too-rapid deployment might lead to installation of systems that are not optimally efficient as to spectum use. Also, requiring a high percentage of customers in a large service area to be served by LMDS may lead to mis-application of the technology in places for which it is not well suited: specifically, areas blocked by terrain or trees.

1. The Commission Should Establish an Advisory Committee

The Commission should establish an advisory committee to propose a compromise between the interests of LMDS services and satellite services. However, there are additional subjects of a technical nature which interact with the spectrum allocation question, and which are also relevant in and of themselves. The NRC should be chartered to deal with such questions as the effect of trees and terrain [see section 3, below], or other technical matters, such as the question of probability of interference between services, which could affect the success of a plan for the 28 GHz band.

A proposed ammended "question to the committee" is:

> What technical rules should be adopted for the LMDS and/or the fixed satellite service so as to maximize the sharing of spectrum among these services? *What technical obstacles are there to the success of either service, and how should rules account for these?* [*Italics* = added text]

---

1. Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Band and to Establish Rules and Policies for Local Multipoint Distribution Service, CC Docket No. 92-297, SECOND NOTICE OF PROPOSED RULEMAKING [2nd NPRM], Jan. 19, 1994, paragraph 39.
2. See: 2nd NPRM, paragraph 40.

2. The Commission Should Not Hinder LMDS with Over-regulation

28 GHz LMDS will face stiff competition from established cable TV services, newly-emerging satellite TV services, and soon-to-be installed 2-way video-on-demand cable-based services. The public interest will best be served by an LMDS service which can carry at least as much programming and two-way services as these competing technologies. Therefore, the Commission should not enshrine non-competitive technology; either directly, by adopting overly-specific rules; or indirectly, by requiring too-rapid deployment [e.g. by requiring 90% coverage within 3 years].

The Commission should not constrain licensees to use any particular modulation, channelization, polarization, or cell management techniques. Within their respective license areas, operators will be motivated to do what works best, both technically and commercially. They should be allowed to do so, subject to the sole constraint that they not interfere with other services.

HP joins the many commentors who point out that the video compression technology just now being implemented offers the possibility to provide more service in less bandwidth than does analog FM. Therefore, to best serve the long-term public interest, the Commission should not *de facto* mandate analog FM by requiring too-rapid deployment, thus forcing licensees to prematurely commit to to that older, less bandwidth-efficient modulation scheme.

However, sufficient information is unavailable, and is unlikely to become available during the rulemaking period, to

clearly establish *which* form of digital modulation will be acceptable in field installations. Therefore, the Commission should not ask its Negotiated Rulemaking Committee to recommend, nor should the Commission itself choose, *any* particular modulation format as mandatory for LMDS services.

3. Trees Attenuate 28 GHz Waves: Rules Should Account for This

Contrary to previous assertions,[3] NTIA studies do indeed show that 28 GHz signals are severely attenuated by trees in the propagation path. In a 1989 study, NTIA authors state: "For the first 30 meters of foliage depth, the increase in vegetation loss [is] nearly linear at a rate of 1.3 to 2.0 dB per meter...".[4] This same report shows attenuations of approximately 2 dB per meter of foliage depth for both Douglas fir and Pecan trees.[5] A subsequent NTIA Report shows that a single pecan tree attenuates 28.8 GHz waves 12dB without leaves and 18dB with leaves.[6]

In its first NPRM, the Commission called for "...service for 90% of the population within the service area within 3 years...",[7] and the second NPRM appears not to ammend the point. Interpreted literally, this would require a service provider to incur great

3. Reply comments of Suite 12 Group, April 15, 1993, pg. 17.
4. Jones, D.L., Espeland R.H., and Violette, E.J., "Vegetation Loss Meaurements at 9.6, 28.8, 57.6 and 96.1 GHz Through a Conifer Orchard in Washington State," NTIA Report 89-251, October, 1989, pg. 64.
5. *ibid.*, pp. 32, 60.
6. Papazian, P.B., Jones, D.L., and Espeland, R.H., "Wideband Propagation Measurements at 30.3 GHz through a Pecan Orchard in Texas," NTIA Report 92-287, September, 1992, pg. 27, lower graph.
7. Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Band and to Establish Rules and Policies for Local Multipoint Distribution Service, CC Docket No. 92-297, NOTICE OF PROPOSED RULEMAKING... [1st NPRM], Dec. 10, 1992, paragraph 47.

expense in order to bring 28 GHz signals to customers located in wooded suburban or rural areas, since a complicated system of reflectors and/or repeaters would be needed to achieve 90% coverage. Such a requirement could have the unintended effect of discouraging 28 GHz LMDS service development, since license holders would be forced to mis-apply the technology as a condition of their license.

At the very least, the Commission should adopt a flexible set of rules which would allow a license holder to apply 28 GHz technology to locations (e.g.cities) where it may be advantageous compared to cable alternatives, while utilizing more appropriate technologies in areas where trees or terrain attenuate signals. In areas where trees or terrain affect a portion of homes, operators should not be required to provide service if obstacles block the broadcast line-of-sight. LMDS providers will be motivated to supply signal to as many customers as possible. Where LMDS can not provide service at a reasonable cost, consumers will still have alternative suppliers of video programs through cable and satellite services.

The NRC should consider various LMDS technical limitations such as that cited above, since such limitations may have a profound effect on the ultimate success or failure of the Commission's policies for the 28 GHz band. The NRC should also consider objectively the issue of satellite/LMDS interference, and advise The Commission of its findings.

HEWLETT-PACKARD CO.

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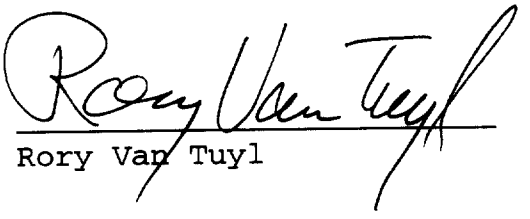
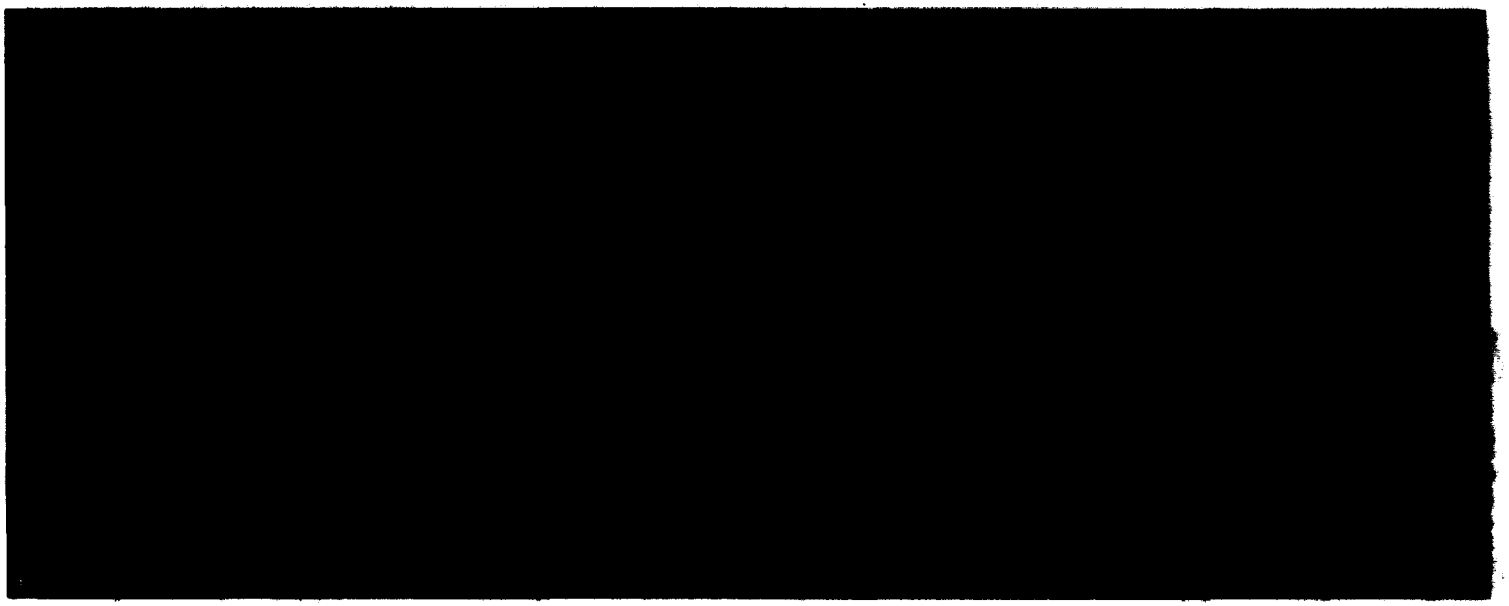
April 6, 1994



Rory Van Tuyl

# Hewlett-Packard Laboratories

*.....Solid State Technology Laboratory, Palo Alto California*



April 6, 1994

Rory Van Tuyl, Department Scientist

HEWLETT PACKARD

3/22/94

# A Proposal

***.....For Ammended "Question to the Committee"***

"What technical rules should be adopted for the LMDS and/or the **fixed satellite service so as to maximize the sharing of spectrum among these services?** ***What technical obstacles are there to the success of either service, and how should rules account for these?***

# Over - Regulation Will Kill LMDS

- **Video Compression Technology is Rendering the Analog FM Approach Obsolete**
- **The Commission Should Not Enshrine this Obsolete Technology**
- **Forcing 90% Deployment in 3 Years Could Do Just That!**
- **Unproven Techniques, Such as Specific Cell Polarization Schemes Should Not Be Mandated**

# Trees Attenuate 28 GHz Waves

*.....Rules Should Account for This*

- **NTIA Studies Show that 28 GHz Waves are Attenuated at the Rate of 2 dB per Meter of Foliage Depth**
- **Confidential Private Field Trials Show that Trees are a Severe Limitation**
- **If Licensees are Required to Cover 90% of Population in a BTA with 28 GHz LMDS, Installations Would Be Too Expensive and Wasteful**
- **Make Rules Flexible, or LMDS Will Never Fly!**

# Annotated Extracts From NTIA Papers on 28 GHz Attenuation Through Trees

NTIA Report 89-251

# Vegetation Loss Measurements at 9.6, 28.8, 57.6, and 96.1 GHz Through a Conifer Orchard in Washington State

David L. Jones
Richard H. Espeland
Edmond J. Violette

U.S. DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary

Janice Obuchowski, Assistant Secretary
for Communications and Information

October 1989

# Vegetation Loss Measurements at 9.6, 28.8, 57.6, and 96.1 GHz Through a Conifer Orchard in Washington State

D.L. Jones, R.H. Espeland, and E.J. Violette*

Propagation measurements were made in the Olympic National Forest of Washington state during October 1987 to examine millimeter-wave signal propagation through conifer vegetation. Linearly polarized continuous-wave signals at 9.6, 28.8, 57.6, and 96.1 GHz were used to evaluate attenuation, depolarization, and backscattering from conifer trees. Azimuth and elevation scans were conducted for various transmitter heights and path lengths. Results from the measurements are presented and compared with data gathered from similar measurements taken through deciduous vegetation.

Key words: attenuation; backscatter; depolarization; millimeter-wave; propagation; vegetation

## 1. INTRODUCTION

In 1982, the Institute for Telecommunication Sciences (ITS) conducted a measurement program to determine the propagation characteristics of millimeter-wave signals through deciduous vegetation. These measurements, at 9.6, 28.8, and 57.6 GHz, emphasized the determination of received signal properties as a function of foliage depth in order to support the development of a model for predicting link performance. Results of these measurements indicate that the received signal levels are highly dependent on the relative position and pointing of the antennas in the orchard (Schwering et al., 1988; Violette et al., 1983). A significant difference in signal loss between foliated and defoliated states of the orchard is also apparent. As an extension of this work, ITS conducted similar measurements in 1987 to study the propagation of millimeter-wave signals through conifer vegetation.

These conifer propagation measurements were made in late October and early November 1987 at a U.S. Forest Service seed orchard in the Olympic National Forest of Washington State. This location was chosen for its uniform tree sizes and densities, which provided a controlled measurement environment. Most of the measurements were made

*D.L. Jones is with the Institute for Telecommunication Sciences, National Telecommunications and Information Administration, U.S. Department of Commerce, Boulder, CO 80303.

R.H. Espeland and E.J. Violette are research associates with the University of Colorado CIRES Department, Boulder, CO 80309.

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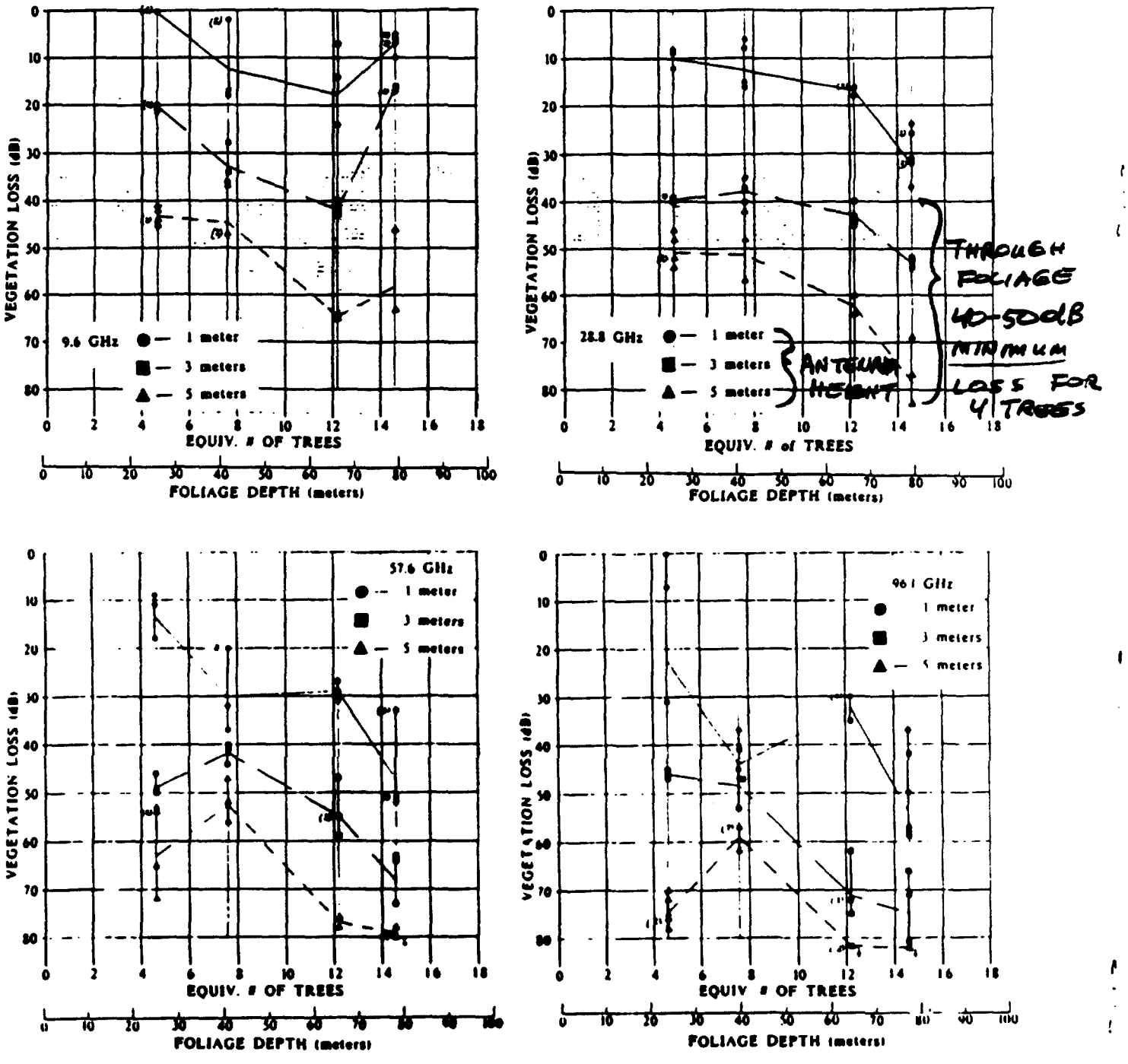


Figure 19. Vegetation loss as a function of foliage depth from peak signal pointing data on paths 4, 5, 6, and 7.

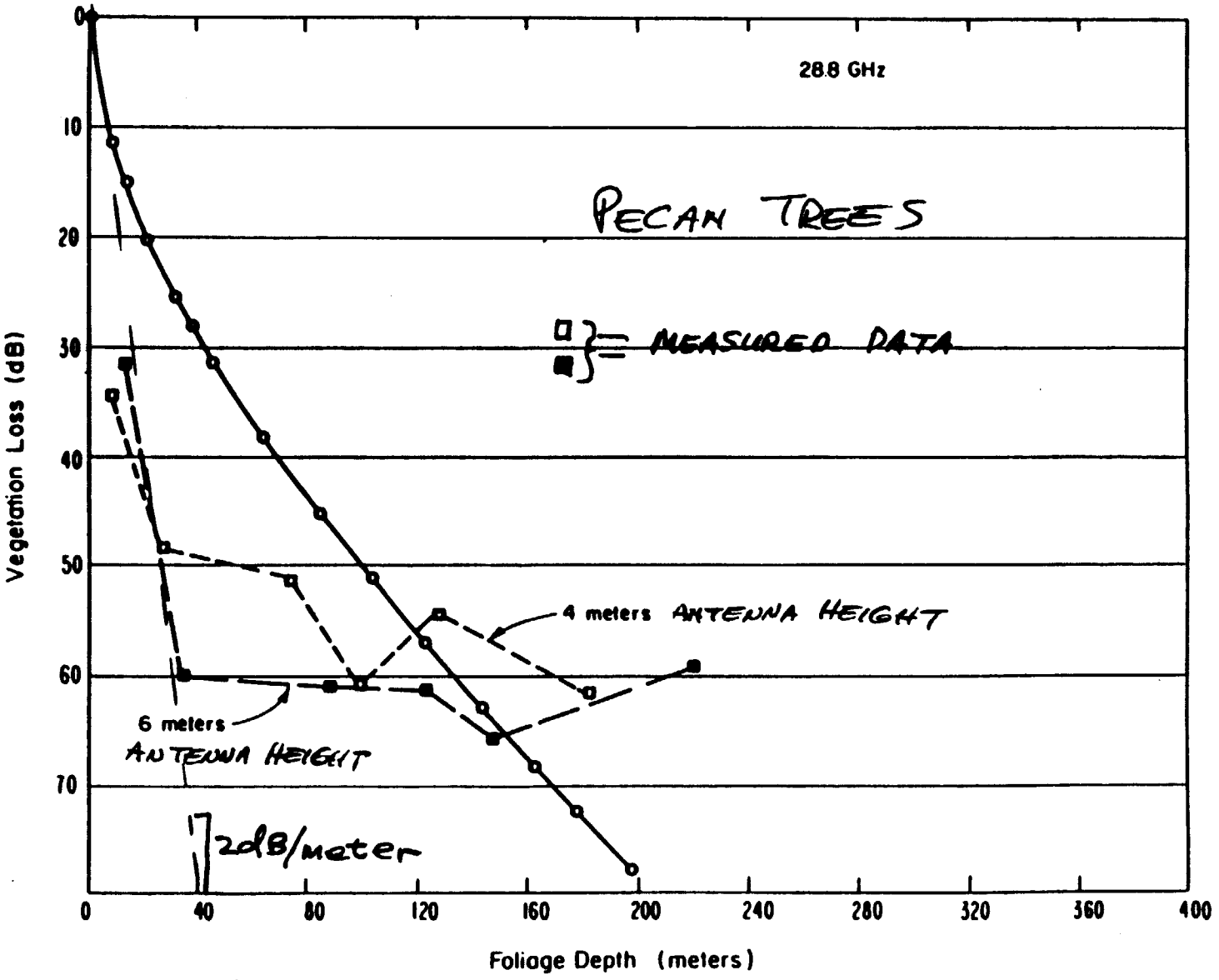


Figure A.6 Measured and predicted values of vegetation loss as a function of foliage depth for 28.8 GHz.

with VV polarization, take on a 300 meter path at a 1 meter height. The height over ground for unobstructed antenna patterns affects the elevation plots slightly as the ground reflection produces a multipath signal. [1]

Azimuth and elevation angle scans at the 4 meter height without leaves, Figure A.8, show a gradual loss of signal directivity, with increasing tree depth and at the 11 tree depth, the signal level is nearly flat over all scans. For the foliated state at 4 meters, Figure A.9, the flattening out of the signal level occurs at the 8 tree depth. This suggests that the energy is scattered nearly equally from the entire tree. At the 4 meter level, the receiving antenna is generally 2 to 4 meters from the branches, but 12 to 14 meters from the trunk of the last tree on the path. The ±15° azimuth scans illuminate nearly the full width of the tree except for some branches that may be partially obscured at the extreme outer edge. The elevation scan at ±10° almost illuminates the highest branches of the closest tree to the receiving antenna at the 4 meter height and passes through many layers of branches before intersecting the ground at the -10° pointing. This estimate of the pointing geometry is included to point out that no over-the-top or down-the-row mode of propagation was detected.

## 3. CONCLUSIONS

Measurements at 9.6, 28.8, and 57.6 GHz were made to describe vegetation loss. A well-established, uniformly planted pecan orchard was chosen because the density of foliage was very constant with distance. At tree trunk height (1 meter with no underbrush) and at branch heights with trees in defoliated state (early spring), the vegetation loss curve takes on a decreasing, nearly linear shape as a function of number of trees. In contrast, at branch height (4 and 6 meters) in a foliated state, the curve makes an abrupt break at a foliage depth of about 30 meters. For the first 30 meters of foliage depth, the increase in vegetation loss in nearly linear at a rate of 1.3 to 2.0 dB per meter, depending on frequency, and beyond 30 meters, the curve decreases at an exponential rate that averages only 0.05 dB loss per meter. The shape of the vegetation loss curve as a function of foliage depth is interpreted as an initial loss rate due to the high attenuation of the direct path mode, and beyond 30 meters, a low loss rate due to the multiple scatter mode. These data also show a clear trend for increased losses with increased frequency but not in a


NTIA Report 92-287

# Wideband Propagation Measurements at 30.3 GHz through a Pecan Orchard in Texas

P.B. Papazian
D.L. Jones
R.H. Espeland


**U.S. DEPARTMENT OF COMMERCE**
**Barbara Hackman Franklin, Secretary**

Gregory F. Chapados, Assistant Secretary
for Communications and Information

September 1992

# Wideband Propagation Measurements at 30.3 GHz Through a Pecan Orchard in Texas

Peter B. Papazian*, David L. Jones** and Richard H. Espeland***

Wideband propagation measurements were made in a pecan orchard in Texas during April and August of 1990 to examine the propagation characteristics of millimeter-wave signals through vegetation. Measurements were made on tree obstructed paths with and without leaves.

The study presents narrowband attenuation data at 9.6 and 28.8 GHz as well as wideband impulse response measurements at 30.3 GHz. The wideband probe (Violette et al.,1983), provides amplitude and delay of reflected and scattered signals and bit-error rate. This is accomplished using a 500 MBit/sec pseudo-random code to BPSK modulate a 28.8 GHz carrier. The channel impulse response is then extracted by cross correlating the received pseudo-random sequence with a locally generated replica.

Key words: attenuation; delay spread; impulse response; millimeter-wave propagation; vegetation; wideband

## 1. INTRODUCTION

Over the past eight years, the Institute for Telecommunication Sciences (ITS) has conducted a variety of experiments in an effort to characterize the propagation of millimeter-wave signals through vegetation. These experiments involved the measurement of the received strength of narrowband millimeter-wave signals propagated through both coniferous and deciduous vegetation, at frequencies of 9.6, 28.8, 57.6 and 96.1 GHz. The results of these measurements have revealed much about the variation of received signal level with parameters such as carrier frequency, antenna polarization, antenna pointing angle, antenna position, foliage depth, and type of vegetation (Jones et al., 1989; Schwering et al., 1988; Violette et al., 1981; Violette et al., 1983).

As an extension of this work, ITS has configured its wideband millimeter-wave probe to make similar measurements. The wideband probe can provide a more complete characterization of the effects

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** David L. Jones is a former employee of the Institute for Telecommunication Sciences, National Telecommunications and Information Adminstration, U. S. Department of Commerce, Boulder, CO 80303.

*** Richard H. Espeland is an independent contractor.

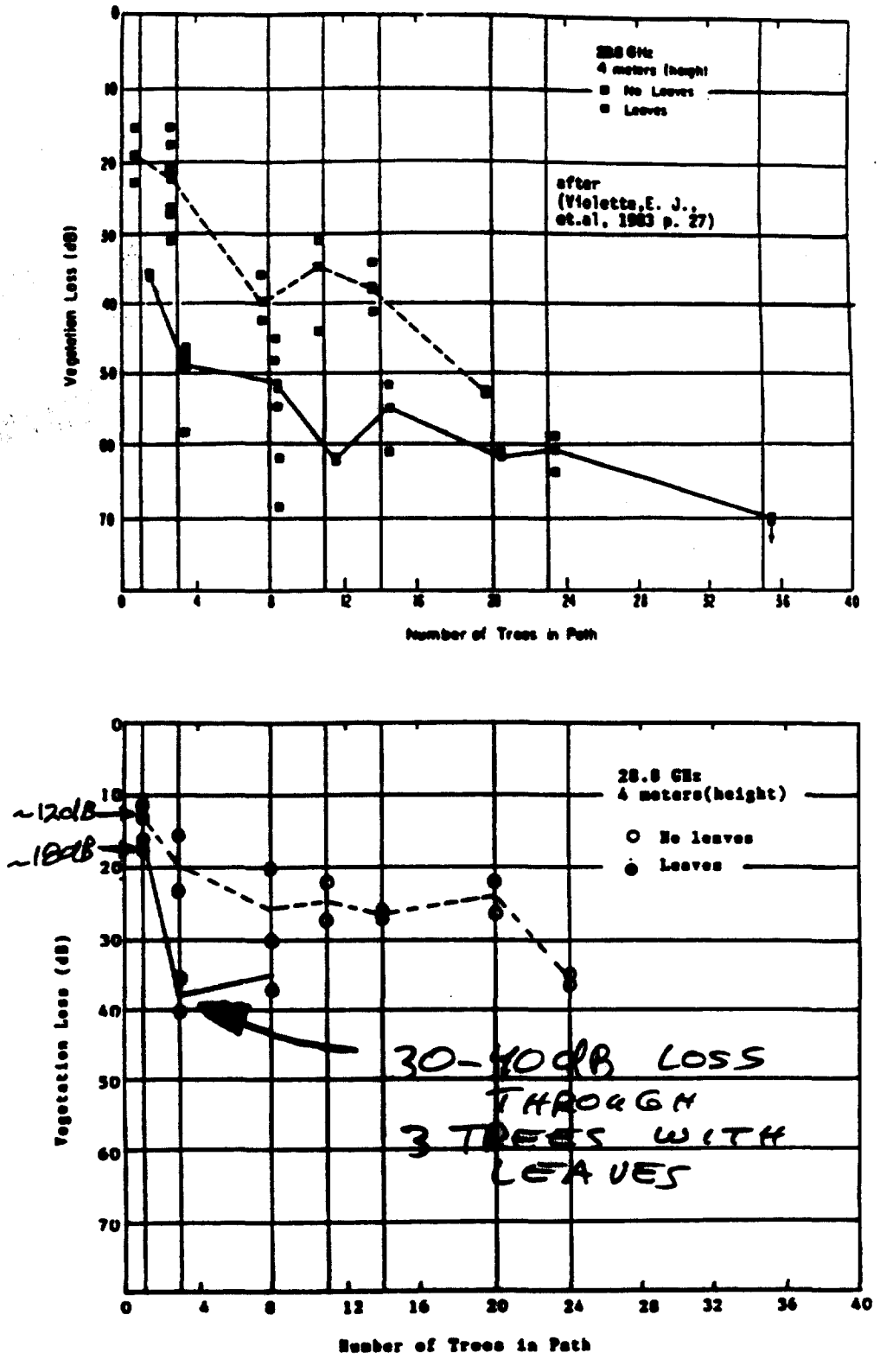


Figure 4.5. Vegetation loss as a function of the number of trees on path for 28.8 GHz at 4 meters.